

WHAT IS CLAIMED IS:

1. A method to determine optical deviations caused by an aircraft canopy that comprises:

generating a collimated beam of light to illuminate a 3-D
5 pilot eye volume (PEV);

passing the collimated beam of light through an array of subapertures, each projecting a collimated beam of light;

directing the patterned collimated beams of light to produce an undistorted image on an imaging screen, wherein the
10 undistorted image is electronically imaged and stored in memory;

directing the patterned collimated beam of light through the aircraft canopy, wherein the aircraft canopy distorts the patterned collimated beam of light to produce a distorted image on an imaging screen, wherein the distorted image is
15 electronically imaged and stored in memory;

comparing the distorted image to the undistorted image to determine the optical distortions caused by the aircraft canopy.

2. The method of Claim 1, wherein the collimated beam of
20 light is generated external to the aircraft canopy and imaging screen is located within the aircraft canopy.

3. The method of Claim 1, wherein the collimated beam of light is directed to the 3-D PEV from various azimuth viewing
25 angles and elevation viewing angles over the 3-D PEV.

4. The method of Claim 1, wherein the collimated beam of light is generated within the aircraft canopy and imaging screen is located external to the aircraft canopy.

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5. The method of Claim 1, wherein a distance between the aircraft canopy and the imaging screen is varied between a first distance and a second distance.

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6. The method of Claim 5, that further comprises:
recording a pair of distorted images at the first distance and second distance; and
recording a pair of undistorted images at the first distance and second distance.

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7. The method of Claim 1, wherein a width of the patterned collimated beam of light exceeds a width of the 3-D PEV within the aircraft canopy.

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8. The method of Claim 1, wherein the collimated beam of light is a filtered white light source.

9. The method of Claim 1, wherein the array of small subapertures comprises a Hartmann mask.

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10. The method of Claim 1 that further comprises generating an image displacement map from the comparison of the distorted image to the undistorted image.

11. A method to determine optical deviations caused by an aircraft canopy that comprises:

placing a contrasting optical pattern external to the aircraft canopy;

5 recording an undistorted image of the contrasting optical pattern with a camera located within the 3-D PEV, wherein the undistorted image is stored in memory;

placing the aircraft canopy between the pilot's eye centroid and the contrasting optical pattern;

10 recording a distorted image of the contrasting optical pattern with the camera located within the 3-D PEV, wherein the distorted image is stored in memory; and

comparing the distorted image to the undistorted image to determine the optical distortions caused by the aircraft canopy.

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12. The method of Claim 11, wherein a size and height of the contrasting optical pattern determine the elevation and azimuth angles measured by the undistorted image and distorted image relative to the 3-D PEV.

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13. The method of Claim 11, wherein a distance between the aircraft canopy and the contrasting optical pattern is varied between a first distance and a second distance.

14. The method of Claim 11 that further comprises:

recording a pair of distorted images at the first distance
and second distance, wherein pair of distorted images are stored
in memory; and

5 recording a pair of undistorted images at the first distance
and second distance, wherein the pair of undistorted images is
stored in memory.

15. The method of Claim 11 that further comprises

10 generating an image displacement map from the comparison of the
distorted image to the undistorted image.

16. An apparatus to determine optical deviations caused by an aircraft canopy that comprises:

a light source to generate a beam of light;

5 a collimator, optically coupled to the light source to collimate the beam of light;

a plurality of subapertures to pattern the collimated beam of light;

10 an imaging screen that receives the patterned collimated beam of light and produces and records images of the patterned collimated beam in memory, wherein:

an undistorted image is produced, recorded and stored in memory when the aircraft canopy is not placed in a path of the patterned collimated beam of light;

15 a distorted image is produced, recorded and stored in memory when the aircraft canopy is placed in a path of the patterned collimated beam of light and distorts the patterned collimated beam of light;

20 a processing unit operable to compare the distorted image to the undistorted image and determine the optical distortions caused by the aircraft canopy.

17. The apparatus to determine optical deviations caused by an aircraft canopy of Claim 16, wherein the light source to generate a beam of light, the collimator, and the optical patterning assembly are located external to the aircraft canopy and the imaging screen is located within the aircraft canopy.

18. The apparatus to determine optical deviations caused by an aircraft canopy of Claim 17, wherein the collimated beam of light is directed to a 3-D PEV from varying elevation and azimuth angles external to the aircraft canopy.

19. The apparatus to determine optical deviations caused by an aircraft canopy of Claim 16, wherein the light source to generate a beam of light, the collimator, and plurality of subapertures are located within the aircraft canopy and the imaging screen is located outside of the aircraft canopy.

20. The method of Claim 19, wherein a distance between the aircraft canopy and the imaging screen is varied between a first distance and a second distance.

21. The apparatus to determine optical deviations caused by an aircraft canopy of Claim 20, wherein:

a pair of distorted images at the first distance and second distance are recorded and stored in memory; and

5 a pair of undistorted images at the first distance and second distance are recorded and stored in memory.

22. The apparatus to determine optical deviations caused by an aircraft canopy of Claim 16, wherein a width of the patterned collimated beam of light exceeds a width of the 3-D PEV within the aircraft canopy.

10 23. The apparatus to determine optical deviations caused by an aircraft canopy of Claim 16, wherein the collimated beam of light comprises a filtered white light source.

15 24. The apparatus to determine optical deviations caused by an aircraft canopy of Claim 16, wherein the plurality of subapertures comprise a Hartmann mask.

20 25. The apparatus to determine optical deviations caused by an aircraft canopy of Claim 16, wherein the processing unit generates an image displacement map from the comparison of the distorted image to the undistorted image.

26. An apparatus to determine optical deviations caused by an aircraft canopy that comprises:

a contrasting optical pattern external to the aircraft canopy;

5 a camera located within the 3-D PEV operable to record:

an undistorted image when the aircraft canopy is not placed in a path of the patterned collimated beam of light;

a distorted image when the aircraft canopy is placed in the path of the patterned collimated beam of light and

10 distorts the patterned collimated beam of light;

a processing unit operable to:

receive and store the undistorted image and distorted image in memory coupled to the processing unit;

compare the distorted image to the undistorted image

15 and determine the optical distortions caused by the aircraft canopy.

27. The apparatus to determine optical deviations caused by an aircraft canopy of Claim 26, wherein a size and height of the
20 contrasting optical pattern determine the elevation and azimuth angles measured by the undistorted image and distorted image relative to the 3-D PEV.

28. The apparatus to determine optical deviations caused by an aircraft canopy of Claim 26, wherein a distance between the aircraft canopy and the contrasting optical pattern is varied between a first distance and a second distance.

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29. The apparatus to determine optical deviations caused by an aircraft canopy of Claim 28, wherein the camera is further operable to:

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record a pair of distorted images at the first distance and second distance, wherein pair of distorted images are stored in memory; and

record a pair of undistorted images at the first distance and second distance, wherein pair of undistorted images are stored in memory.

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30. The apparatus to determine optical deviations caused by an aircraft canopy of Claim 29, wherein the processing unit is further operable to generate an image displacement map from the comparison of the distorted image to the undistorted image.

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